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University of Cambridge School of Agriculture Memoirs

Memoir No. 29

A summary of the papers published by the members of the Staff of the School of Agriculture and its Associated Research Organisations during the period Oct. 1st, 1956—Sept. 30th, 1957.

Review Series

No. 12. Entomology and Nematology in the School of Agriculture, 1899—1956

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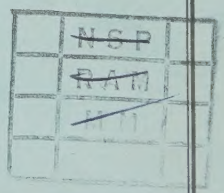

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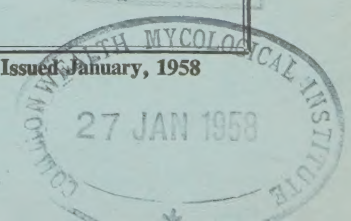

FOREWORD

This Memoir, which is published under the general editorship of the Librarian of the School, represents an attempt to present as succinctly as possible by means of author summaries the contributions made by members of the Staff of the School of Agriculture and its Associated Research Organisations to the development and progress of Agricultural Science, to indicate to research workers interested the Journals in which the full papers are presented and to act as a complete record of papers published.

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Entomology and Nematology in the School of Agriculture, 1899–1956*

By

F. G. W. JONES, M.A.

(*University Lecturer in Agricultural Entomology, 1947–1955*)

The Department of Agriculture was founded in 1892 but already in 1891 a course in agricultural entomology had been given for senior students who proposed to take up agricultural teaching. Among these was Cecil P. Warburton, who eight years later began lecturing in Agricultural Entomology, and continued until 1932, a period of 33 years. In 1893 he was appointed Consultant Zoologist to the Royal Agricultural Society and, annually from 1893 to 1940, he produced a report which gave brief descriptions of pests, together with notes on their natural history and such recommendations for control as were appropriate at the time. These reports covered a wide field. The first[103], for example, contained accounts of gape worm in fowls, sheep bot fly, Mediterranean flour moth, black currant gall mite, chafer grubs, root flies and cutworms, showing that the principal pests were much the same then as now. In some reports Warburton concentrated on groups of pests. Thus, in 1903[105] he dealt with pests of forest trees, while in 1923[107] he concentrated on pests of cereals. Until the School of Agriculture was built in 1910, the reports emanated from the Department of Zoology but thereafter from the School itself. In 1902 Warburton[104] reviewed the control of pests attacking orchard and bush fruits. These reports were interesting and valuable contributions to agricultural entomology but his primary interests were followed in the Molteno Institute of Parasitology where he studied ticks, describing new species in a series of papers published in Parasitology and elsewhere[108, 106] and joining with others in a monograph on the Ixodidae[44]. At the time of writing Warburton is alive and well, having passed his 100th birthday in February, 1954.

In 1913 F. R. Petherbridge was appointed Advisory Biologist and continued in that post for 34 years until shortly after the dissolution of the old Advisory Service in 1946 and its incorporation in the new National Agricultural Advisory Service located outside the University. Petherbridge played only a minor part in formal teaching in the School. His genial influence was exercised in the supervision of students and the training of research workers, many of whom now hold important posts. At first, single handed, he was expected to advise on pests and diseases throughout the Eastern Advisory Province and to undertake seed testing. The pace of life however was slower then and the arrival of an adviser, usually by train, pony cart or bicycle was as much a social as a scientific occasion. Later, after the appointment of Dr W. A. R. Dillon Weston as Mycologist, Petherbridge was able to devote his time entirely to pests. Together Petherbridge and Weston were able to win the confidence of East Anglian farmers and to enhance the reputation of the School of Agriculture both provincially and nationally as a source of advice on pests and diseases.

Petherbridge's approach to research was essentially practical and many students fresh from academic training have cause to thank him for thorough grounding in field work. Where the pest concerned was new or little known, a description was usually given. Studies of incidence, life cycle, general biology and parasitism were undertaken in field and laboratory and from the knowledge gained, field experiments were made on cultural or chemical control. In the early years, the powerful persistent modern insecticides were unknown. For field-crops there were few satisfactory insecticides and the position was little better for fruit crops.

A good deal of Petherbridge's early work was done on fruit in the Histon-Cottenham and Wisbech areas. Attempts were made to control apple sucker and leaf curling plum aphid with concoctions of such unpromising materials as sulphur, lime, waterglass and washing soda[46].

** This is the twelfth of a series of articles summarising phases of agricultural research particularly associated with the School of Agriculture since its inception, previous contributions having dealt with :—Physiology of Reproduction, Plant Virus Research, Plant Breeding, Animal Nutrition, Horticulture, Agricultural Economics, Field Drainage, Animal Production, the Cambridge University Farm, Crop Husbandry, and Agricultural Teaching. Further contributions on other work will appear in future issues.*

Useful results were obtained against sucker nymphs with nicotine washes[47]. Petherbridge and Hussain[60] described the apple capsid and obtained control of the nymphal stages, also with nicotine washes. Later, in a series of experiments in four counties Petherbridge and Weston[48] tried out the newly introduced tar distillate washes on dormant trees. Rosy apple aphid and leaf-curling plum aphid were controlled. Partial control of winter moth eggs was also obtained but the washes had no influence on red spider eggs. Indeed, in some sprayed orchards red spider populations were increased later in the year—early evidence that control of one pest problem may create or intensify another. Petherbridge and Thorpe[76] studied the common green capsid which had changed its habits and become a serious pest of currants, gooseberries, strawberries and other plants. A series of trials by Petherbridge and Hey[59] compared tar distillate washes with washes made to the Long Ashton formula and with combined tar oil and mineral oil sprays. Tar oil controlled aphids and gave a partial control of winter moth while mineral oil controlled capsids and red spider. Combined washes, although reasonably successful in controlling both groups of pests, were liable to cause injury to the trees.

Sawflies attacking fruit were also studied and successful control measures devised. The method of feeding of apple sawfly was described[54] and control achieved for the first time by means of a nicotine/soft soap spray applied 6–8 days after petal fall[77]. Miles, Thomas and Hey[36] described the plum sawfly. Petherbridge, Thomas and Hey[75] studied its life cycle and obtained a measure of control with combined nicotine/lead arsenate sprays. Later, Petherbridge, and Thomas[71] obtained partial control with a nicotine/lead arsenate spray and with derris wash but were more successful with quassia extract[74]. Two interesting records were also made, one of dock sawfly feeding on apple[52] and the other of the occurrence in a Cambridge garden of pear sawfly[93], a continental insect not previously known in Great Britain. Other observations on pests of fruit included strawberry tortrix[49], apple bud weevil[58], thrips on plums and damsons[51], raspberry beetle[68] and the tortrix moth, *Cacoecia crataegana*[10]. The elusive *Aphis petherbridgii* (*?Brachycaudus cardui*), found only in Petherbridge's garden, was described by the late Fred Theobald.

Among field crops, early interest centred around frit fly on spring oats and winter wheat. Petherbridge[53] carried out trials with sowing dates on the University Farm which showed clearly the value of early sowing for the control of frit fly in spring oats. Attacks on winter wheat after rye grass leys were shown to be due to migration of the larvae from the ploughed-in grasses[48, 50]. Pests of similar type namely, the wheat shoot beetle and the rustic moth, were also studied [64, 72-73] and a common measure of control found in the early breaking of leys to avoid oviposition. This, however, was liable to lead to wheat bulb fly attacks. Bulb fly itself was also investigated. Petherbridge[51] found that the insect was peculiar in that eggs were laid in July/August on bare or sparsely covered soil and not directly on the host plant. A few eggs hatched in the autumn, but the main hatch occurred in the early spring. Experiments by Petherbridge, Stapley and Wood[66] on depth of ploughing, time of sowing, and manuring showed that early sowing was advantageous, while different depths of ploughing or applications of superphosphate did not prevent attacks. Mustard, sown as a catch crop following potatoes, kept the land covered and resulted in a lower rate of bulb fly attack although oviposition was not eliminated. I. Thomas, who had joined Petherbridge in 1929 as Assistant Advisory Entomologist, studied dipterous pests of cereals, describing the life history, bionomics and morphology of *Opomyza florum* Fab., *O. germinationis* L. and *Geomyza tripunctata* Fall.[91, 92, 93], three species of Diptera the larvae of which are commonly found along with those of the frit fly and wheat bulb fly in samples of plants from affected fields. Thomas[90] also studied the fungus gnat, *Sciara nitidicollis* Meig., which oviposts freely on scarred vegetable roots.

Until γ BHC became available at the end of the Second World War, wireworms were important pests for which no satisfactory control measures were available. Miles and Petherbridge [34, 35] reviewed the position in 1927. They found that there was a downward migration of the larvae in autumn and upward migration in spring and that maximum feeding activity occurred in the periods March-April-May and September-October. Attractant baits were tested and germinating wheat found best. For control, it was suggested that granular calcium cyanide should be applied to bait-rows about three weeks after sowing by which time the maximum number of wireworms were assembled. Petherbridge[55] later showed that wheat drilled as a bait

between the rows of sugar beet on wireworm infested land was promising as a control measure. Extensive trials by Jones & Jones[14] on increased seed rates and interdrilling with wheat showed that this method was not always reliable; farmers found that bait and crop alike were sometimes consumed.

The onset of the Second World War and the vigorous policy of ploughing up grass which followed resulted in expansion of work on wireworms and the setting up of " wireworm teams " whose primary function was to estimate the wireworm population of grass newly ploughed or about to be ploughed and to advise on the crops it would be safe to grow. J. H. Stapley, G. C. Varley (now Prof. Varley), F. J. Simmonds, D. M. Ross, G. F. Cockbill, V. E. Henderson, E. Dunn, A. H. Strickland and P. S. B. Digby all served for various times in the teams operating from the School of Agriculture. At the onset of war, soil extraction techniques were rapidly improvised and reliance was mainly on hand sorting. Later, methods improved, and finally a rapid, wet method was devised. Petherbridge[56] summarised the relationship between crop injury and levels of population density estimated by the dry method but, when the wet method came into use, these levels needed to be doubled. Cockbill, Henderson, Ross and Stapley[1] described the wet method and analysed some of the results obtained by its use [2, 80, 89]. Seasonal changes observed in the population of six grass fields showed fluctuations that were difficult to explain on the basis of the wireworm's life cycle. In fields newly ploughed from grass, no appreciable decline in population occurred until the following spring: after the first crop the decline varied from 30—70 per cent. After bare fallow populations were reduced, sometimes to less than 10 per cent., of the original level, and wireworms less than 5 mm. long were practically eliminated. Ploughing early in February or March had a greater effect than ploughing in May. Attempts to correlate patches of severe injury with high wireworm counts were not very successful and the levels between which injury occurred varied greatly from field to field. In the patches the calcium carbonate content of the soil was high and the sand content low. Wireworm activity was evidently affected by unknown soil factors that varied from field to field. When γ BHC became available, interest in the control of wireworms by cultural means declined and work was undertaken upon seed dressings. Jones & Humphries[31] first tried to establish the dosage rates which were safe to use on sugar beet and then tested seed dressing in a series of proving trials in which the best stands were obtained from combined dressing of γ BHC and mercurial fungicides. Since the introduction of these dressings, in which the School of Agriculture played a part, the yearly losses of sugar beet from wireworm attack have steadily declined.

Flea beetles had always been troublesome on brassicae. Petherbridge & Thomas[69, 70] tried out a variety of dusts, including inert materials such as hydrated lime, barium fluo-silicate and powdered quartz, mixtures of sulphur/lead arsenate and naphthalene/silica, various types of derris and nicotine dusts. None of these preparations were really satisfactory. Derris dust, if properly applied, was best but the insecticide soon lost its potency. Stapley and Digby investigated the biology of flea beetles during the early years of World War II and attempted control by trap cropping. The results of these attempts are incorporated in Stapley's book[88] but solution of the flea beetle problem came only with the introduction of γ BHC and the other persistent insecticides and especially with the incorporation of the former in seed dressings.

Cabbage aphid was another pest of considerable importance in the market garden areas of West Cambridgeshire and Bedford, and in adjacent parts of Hertfordshire and Huntingdonshire. Petherbridge working with Mellor[62] and later with Wright[79] found that the aphid overwintered as eggs or asexually on cruciferous crops, especially brussels sprouts, and suggested that a measure of control might be obtained by preventing the passage of winged forms from old plants to new ones. This necessitated co-operative efforts by the farmers and attempts were made, by the issue of local pest Orders, to enforce the destruction of residues from old crops and the treatment of seed crops with nicotine dust or spray by mid-May, the critical date for the onset of migration. For various reasons, however, the local Orders were never vigorously enforced.

Warburton had given up lecturing in 1932 and his place was taken by " outside " lecturers, W. H. Thorpe from 1932–1944 and K. M. Smith from 1944–1946. Smith had joined the staff of the Virus Research Station, then attached to the School of Agriculture, in 1927, and studied the insect vectors of potato and other virus diseases[85], a subject which he has later reviewed[87]. He

also published his well-known textbook of Agricultural Entomology in 1931[86]. Stapley had been appointed in 1935, first on a sugar beet grant and later, in 1937, as Assistant Adviser in which post he replaced Thomas. Stapley joined with Petherbridge and others in the publication of numerous papers on diverse subjects and also published a book[88] concerned with the practical aspects of pest control in field crops. D. W. Wright had joined the staff of the Horticultural Research Station (now part of the National Vegetable Research Station) in 1936. His work on vegetable pests and pests of stored grain has also been reviewed by Woodman[117] who himself worked on the physical chemistry of insecticidal sprays in the 1930's. B. D. W. Morley worked for a time on a sugar beet grant but was primarily interested in ants[37-43].

In 1934, an event occurred that greatly influenced Agricultural Entomology in the School of Agriculture and resulted in the School exercising a leading influence in the formulation of the British beet sugar industry's policy in matters concerning insect and nematode pests and in the education of its fieldmen. Petherbridge toured the beet growing areas of Europe to survey the incidence of sugar beet pests and learn something of the methods of control employed against them. His experiences were embodied in a bulletin on Sugar Beet Pests[67]. On returning, a grant was made by the Committee for Sugar Beet Research and Education for the investigation of sugar beet pests. At first field work was undertaken to assess the relative importance of the various pests. Wireworm and pygmy mangold beetle were then the most important seedling pests and the black bean aphid and the peach-potato aphid the most important pests of the mature crop[57]. During this period, the first serious outbreaks of beet eelworm were observed in the Fens and in the Norwich area[65]. Exceptional outbreaks of cutworms, worse than any since recorded, were investigated in 1936[63]. D. P. Jones and F. G. W. Jones were appointed in 1937 and work on the more important beet pests was intensified. Detailed field and laboratory studies of the bean aphid led to a successful system of forecasting the threat of outbreaks from counts of eggs on the spindle tree, the winter host plant[12], and led to the suggestion that its eradication would be beneficial. Committees were set up to consider this and to look into the distribution of the spindle tree. The arguments advanced for and against eradication were debatable but the practical problem of removing the bushes proved far greater than anticipated. Bushes were found more numerous than previously believed so that their detection and removal, and the repair of gaps left in hedgerows, would have proved an enormous task made more difficult by the vigour with which the bush suckers from fragments of root left behind. In the end no action was taken. Concurrently, vigorous summer field surveys determined the distribution of beet eelworm and led to the issue of the first Sugar Beet Eelworm Order [61, 20, 19] which aimed at control by crop rotation. As a by-product it also effectively controlled pygmy mangold beetle. This action early in the history of sugar beet in Great Britain has probably prevented serious crop losses comparable with those experienced in the beet growing areas of Germany and Holland. Study of the rise and fall of soil populations[15], the host range and the life cycle of the eelworm was also in progress[17] as well as unsuccessful experiments on chemical control[11]. The carrion beetle and the sand weevil were also studied[13].

This phase came to an end with the dissolution of the old Advisory Service in 1946. Incorporation of the Horticultural Research Station in the National Vegetable Research Station and the departure of Wright and his colleagues soon followed. The School had lost all its entomologists except F. G. W. Jones who remained with the task of organising teaching and research, a task in which he was later assisted by A. W. Colling. Fortunately the sugar beet grant continued and funds were also obtained from the Agricultural Research Council.

The divorce between advisory and research work made possible greater specialisation on certain problems and an increase in the amount of fundamental work. Sen studied the bean aphid[81], Patel the turnip gall weevil[45], and Colling after much painstaking work succeeded in counting aphid chromosomes[3]. Observations were made by Jones & Humphries on the pygmy mangold beetle, attention being paid to dispersal and flight from old to new beet fields in spring when the new crops were still in the seedling stage[28]. Dunning studied the mangold fly in detail[7, 9] and cheap and successful control measures were devised by Dunning and Jones which were promptly available when outbreaks of unusual severity occurred in 1954–6[28, 8]. A series of trials were made by Jones, Dunning and Humphries to assess the loss of beet yield caused by defoliation and

gapping, types of injury normally caused by seedling beet pests, and to find out how much might profitably be spent on control measures[30]. Sugar beet recovered well from defoliation at the singling stage and there was a considerable measure of compensation around gaps provided these were small and well scattered.

From 1949 onwards increasing interest had been taken in beet eelworm and in eelworm problems generally and a flourishing nematology section with a small field station near the University Farm gradually arose. Jones described a new species of eelworm attacking carrots in the Chatteris area[16] and worked on the differentiation of species of root eelworm and the number of generations occurring each year[17, 18]. He reviewed the beet eelworm position in England and Wales[21] and visited some of the old established beet eelworm areas on the Continent[24]. He also began further studies of soil populations[23, 25]. A microplot technique was developed to overcome difficulties associated with field plots. By this means it was possible to reduce within-field variability in soil structure, fertility and eelworm population, to control plant populations and sowing dates, and to compare eelworm population changes in different soils side by side under the same macroclimate conditions. Using this technique the relative efficiency of some hosts of the beet, pea and cereal root eelworm were assessed[26, 32]. Yield of beet was found to be inversely proportional to the logarithm of the initial beet eelworm population but the percentage sugar content of the roots was unaffected by eelworm attack. The relationship between initial and final eelworm populations was also studied[26]. Experiments were also made with control by the use of predacious fungi, with disappointing results [4, 5]. Dunning found that stem eelworm (oat-onion race) was responsible for a form of blindness in seedling beet, giving rise to the multiple crown condition and associated with autumn crown canker[6]. R. D. Winslow undertook detailed work on host ranges of cyst-forming nematodes and investigated the influence of root diffusates on larval hatch[109, 33, 110]. The tendency of eggs within cysts to be dormant until stimulated to hatch by the proximity of host roots is one of the ultimate refinements of obligate parasitism. The relationship is not perfect, however; non-hosts in families containing hosts often produce active root diffusates and, occasionally, host plants fail to evoke hatch. Trap cropping of potato root eelworm with black nightshade, a non-host with an active root diffusate, reduced the soil population by 50 per cent—too small a reduction to be of practical value[112]. Winslow also showed that field and broad beans were less efficient hosts of the pea root eelworm than peas[111], and worked on the seasonal hatching of cyst-forming eelworms[114]. He described a new method for the recovery of cysts for bioassay[113] and, together with Williams, published a review of some techniques used in nematology[116]. H. R. Wallace investigated the physical factors in soil influencing larval hatch and movement, adapting techniques borrowed from soil physics[95-101]. Soil aeration is the most important single factor associated with soil structure which influences larval emergence from cysts. Pore size and moisture content in the soil are intimately related and their influence is really an expression of their effect on aeration. In comparing emergence and activity in different soils, attention must be paid more to soil structure than mechanical analysis. The greatest rate of hatch and of movement of larvae in the soil occur at the point of inflexion of the moisture characteristic. Wallace also studied the *in vitro* effects of organic and inorganic solutions on larval hatch of the beet eelworm[102].

A new bulletin on sugar beet pests has been prepared by Jones incorporating the results of twenty years' research in the School of Agriculture[27] and replacing the earlier bulletin of Petherbridge[67].

In 1952, Jones began an investigation of resistance in *Solanum tuberosum* ssp. *andigena*, working in collaboration with H. W. Howard of the Plant Breeding Institute and assisted later by Williams[22, 115]. Resistant plants were screened from lines of *S. andigena* at the Field Station and crossed with *S. tuberosum*. Resistance is due to a single dominant gene designated H, which retains its power in back crosses. Resistant plants produce active root diffusates capable of evoking the hatch of larvae from potato root eelworm cysts. The plants are invaded but, although the male appears to develop normally, development of the female is arrested at an early stage, before sexual maturity. Resistance is evidently partial and concerns host efficiency rather than resistance to or tolerance of invasion. Hopes of a solution of the potato eelworm problem by incorporation of the resistant gene into satisfactory commercial varieties are promising but

early enthusiam has been dashed by the discovery of resistance-breaking biotypes of the eelworm. Similar work on resistance of sugar beet to beet eelworm attack is being attempted by Audrey M. Shepherd who has also worked on nematode capturing fungi[82—84].

Looking back, the period reviewed falls into three phases influenced by Warburton, Petherbridge and Jones. The last phase saw the rise of plant nematology and what was probably the first formal course of lectures in that subject in any British university was delivered in the Michaelmas Term, 1955. The diversity of problems studied during the three phases is impressive and the work done, which falls broadly under the heading of ecology, shows the evolutionary tendencies common in applied work, namely, preliminary assessment followed by detailed field work and the gradual transference of specific problems into the laboratory for more fundamental study.

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AGRICULTURAL ECONOMICS

Drying and Storing Grain on the Farm. Pp. 46.

Fm Econ. Br. Rep. No. 44, 1956. Price 4s. Post Free.

The combine harvester is now well established as a method of harvesting cereals. In consequence, the pattern of grain sales from farms has become radically altered. The steady flow of supplies from August to June has been replaced by a seasonal peak just after harvest. The use of this machine does, therefore, raise the problems of who is to dry and store the grain after harvest and, if a farmer undertakes the task, which type of equipment should be chosen.

A survey of over 60 farms was undertaken including samples of the three principal types of equipment: the continuous drier, the ventilated bin and the sack drier. The basic data cover the three years 1952 (a dry season), 1953 (an average season) and 1954 (a wet season). This precaution was particularly necessary because costs per ton vary greatly according to throughput, and this in turn depends on weather conditions. To give an up-to-date comparison, however, all costs are revalued at 1956 price levels.

For drying equipment alone, a continuous drier handling 1 to 2 tons per hour would cost around £1,800 including installation. The average cost per ton dried is 21s. but this varies according to output from 55s. with a throughput of 100 tons down to 12s. 6d. for 800 tons. Assuming that a contractor could quote a price of 45s. per ton, it would pay a farmer to install his own equipment if the average throughput exceeded 125 tons per annum. Drying equipment for ventilated bins might cost from £475 for 100 tons capacity to £675 for 200 tons capacity. The cost of operating the latter would fall from 71s. per ton for 25 tons to 15s. for 300 tons. Against a quotation of 45s. per ton for contract work, it would pay to install such equipment if over 50 tons were handled each year. The average cost of sack driers was £460 but some small models cost considerably less than this. On the same basis as that quoted above, the installation of such equipment would be economic with a throughput of 35 tons (60-hole, oil-fired) or as little as 12 tons (20-hole, electric drier).

Over the whole sample, average costs per ton are in the region of 21s. per ton and are broadly similar for all three groups. Each type of plant is, however, appropriate to a certain range in farm size and attention is given in the report to the determination of the sizes and types of equipment suitable for any given volume of grain. Attention is also given to the cost of storage (which is additional to that quoted above), to other types of grain storage and to non-monetary considerations which must be taken into account in choosing any particular system.

On the wider question of whether the farmer is the appropriate person to undertake drying and storage, this survey shows that:

1. Costs per ton on the farm are likely to compete favourably with those of a contractor. The latter may operate on a larger scale but he may have higher " overhead " costs due to the seasonal nature of the work.
2. The possession of drying and storage facilities places the farmer in a stronger bargaining position.
3. Capital investment for grain production is rapidly increasing. At present prices, the purchase of drills, elevators and binders would cost about £5 per acre for 200 acres of cereals. With a combine harvester, baler and other equipment, this total would rise to £14 and, with drying and storage, to £25 or £30 per acre.

Report on Farming—1955/56. Pp. 38.

Fm Econ. Br. Rep. No. 45. Price 3s. 6d. Post Free.

This report contains the usual data on changes in the economic organisation of nearly 400 farms during the two years 1954/5 and 1955/6. In addition, however, a detailed comparison is given of changes that have taken place on 20 farms that have supplied data from 1935 to 1955. The average size was 208 acres and, in 1935, the net profit was £363 per farm. By 1955 this had increased to £1,610. Much of this increase, however, merely reflects inflation and to eliminate this, the 1935 figures were repriced at present day levels. It appeared that if these farmers had continued to use pre-war methods, the profit would have been £894 per farm. The difference between this figure and the £1,610 quoted above thus reveals a substantial improvement in efficiency. The principal changes are a fourfold increase in fertiliser use, an increase in machinery use and some saving in manual labour. As a result output has increased by 43% and output per £100 labour and machinery by 20%.

The Family Farm. Pp. 36.

Fm Econ. Br. Occ. Pap. No. 4, 1956. Price 3s. Post Free.

This report is an attempt to define the size and type of farm likely to be necessary to support a farmer and his family. After distinguishing between the family farm (normally 20 to 100 acres) and the small holding (usually under 10 acres), some unpublished data from the M.A.F.F. are used to identify the most numerous types of small farm in England and Wales and the size of the most popular " commercial enterprises " found on them.

The next section is concerned with the size of a viable unit which is taken to be one producing a net income of at least £500 per year. Data from the Farm Management Survey are used to show that two thirds of the small family farms (20–50 acres) and one third of the large family farms (50–100 acres) fail to attain this income. It is

apparent, however, that size is not by itself a sufficient criterion. A multiple regression of size and output on income was, therefore, carried out. This showed that to attain this minimum, a 100 acre farm must attain a net output of at least £25 per acre. A 60 acre farm must, however, attain one of £30 per acre and a 20 acre farm at least £58 per acre. To show the implications of these results in practice, a series of examples is given showing the organisation of family farms attaining about £500 per year. This is followed by a consideration of farms that fail to attain this income—the reasons and possible remedies.

A comparison is then given of the efficiency of large and small farms. It is suggested that the inverse relationship sometimes shown between net output per acre and farm size is misleading in as much as there is a systematic tendency for large farms to predominate on poor soil where small farms could not survive. When compared under similar conditions, there is little difference in net (as opposed to gross) output per acre or in crop or livestock yields. Large farms are usually superior in the use of labour and machinery and in output per £100 of resources employed.

On the question of policy, a number of remedies is considered for farms with insufficient output. Some, e.g. introduction of more pigs and poultry, would entail the importation of more feeding stuffs and larger subsidies. Others such as an increase of fruit or vegetable production, are of limited scope. The conclusion is that the amalgamation of smaller units should be encouraged.

Sugar Beet: Costs and Returns 1954. Pp. iv + 12.

Fm Econ. Br. Mimeogr. Rep. No. 52, 1956. 1s. 6d. Post Free.

This report presents the costs and returns from a random sample of 150 sugar beet growers in 5 districts. Gross costs averaged £58 15s. per acre of which harvesting accounted for £15 9s., hand hoeing for £8 16s. and fertiliser for £8 13s. Costs in one heavy land area were £8 per acre higher than this average and in one light land area were £7 less. The average yield of 10·6 tons of washed beet yielded a profit of £13 15s. per acre. Ignoring the value of tops, 9½ tons of beet were required at 1956 prices to cover costs. Details of cultivations, fertiliser use, etc. are given.

Maincrop and Early Potatoes: Costs and Returns 1955. Pp. 24.

Fm Econ. Br. Mimeogr. Rep. No. 53, 1956. 1s. 6d. Post Free.

This report covers the costs and returns on a random sample of 120 farms drawn from four districts: Holland (Lincs.), Isle of Ely, West Central Essex and East Beds. Net costs per acre varied from £95 19s. in Holland to £72 2s. in Beds. The dry season caused low yields in the high land areas but the high prices that resulted gave a reasonable profit in most cases. In the fen areas, where yields were normal, profits were high. The cost of early potato production in Beds. averaged £71 16s. per acre; the profit was £42 per acre. Details of fertiliser use, cultivations, etc. are given.

Dairy Herd Management Scheme 1955/6—Facts and Figures. Pp. 14.

Fm Econ. Br. (*Mimeogr.*).

A sample of 74 herds is divided according to yield and dependence on concentrates into three groups:

" *High Yield* " where herd yields of 1000 gallons and upwards a cow are obtained, heavy reliance being placed on concentrates.

" *Bulk Feed* " where yields of about 800 gallons are obtained largely from bulky foods and grazing.

" *Traditional* " herds falling between the first two groups in that concentrate feeding is less than in the first group and reliance on bulk feeds is less than the second group.

Although under each system just over 3 acres of land are required per cow (and followers), net income per acre for the traditional system is only half that of the other two. Since the majority of herds in the Eastern Counties are kept on traditional lines, this is a matter of some consequence. It is suggested that in most cases it would be more practicable to turn towards the " bulk feed " system rather than the more specialised " high yield " system.

An analysis is also made of the most successful herds in each system.

BRIGGS, M. & JORDAN, P.

Textbook of Economics. 6th ed. Rev. by R. A. Mackness.

Pp. iv + 583.

(Univ. Tutorial Press, London, 1957. 20s.).

1362* MACKNESS, R. A.

Seasonal Production of Beef and Veal in Australia and Consequent Beef Exports.

Emp. J. Exp. Agric. 1956, **24,** 271–7.

This paper presents data on the seasonal pattern of beef and veal production in Australia between 1942 and 1953 and of the seasonal pattern of Australian beef exports between 1935 and 1952. Total Australian production tended to become less seasonally varied between 1948–53 than between 1942–7, although annual production increased from 460,000 tons in the earlier period to 609,000 tons in the latter. Production in Queensland was more seasonally varied between 1948–53 than between 1942–7, but in both periods peak supplies were produced in June July and August. Annual production in New South Wales increased from 130,000 tons between 1942–7 to 187,000, tons between 1948–53 but production was very level from month to month in the later period.

The increasing seasonal pattern of production in Queensland was reflected in the increasing seasonal pattern of exports from Australia because most of the Australian beef exported is obtained from Queensland production. July, August and September were the months of peak exports. From the point of view of the U.K. market this concentration was to be deplored because beef exported from Australia would tend to arrive in the U.K. when homekilled supplies were seasonally above the monthly average.

1380* Mackness, R. A.
Seasonal Production of Beef and Veal in New Zealand and the Consequent Pattern of Exports.
Emp. J. Exp. Agric. 1957, **25,** 133–8.

The main season of beef production in New Zealand between 1949 and 1953 was March to June and this was reflected in the pattern of exports. There has been a tendency for frozen beef exports to become more seasonally varied from 1930 to 1953. Between 1950–3 a very high level of exports was dispatched between June and September, whereas before 1939 exports were spread more evenly over the year. The pattern of chilled beef exports from New Zealand suited the U.K. market because there were peak exports in February and March and above-average shipments in May and June. If that pattern of exports could be achieved again, the U.K. market would be better served.

1394* Sturrock, F. G.
Costing a New Farm Enterprise.
Westminster Bank Rev. May, 1957, 11–13.

The purpose of this article is to describe a method of capital budgeting that could be used to present a case for the granting of credit to a farmer who wished to expand his output.

1363* Sturrock, F. G.
The Economics of Grain Drying on the Farm.
J. Inst. Corn Merch. 1956, **5,** 182–8.
A shorter version of the data given in Report No. 44.

Sturrock, F. G.
Economics of Machinery Investment on the Farm.
J. Inst. Brit. Agric. Enginrs. 1957, **13,** 20–30.

Sturrock, F. G.
Farm Accounting and Management. 3rd ed.
Pp. xii + 215.
(Pitman, London, 1957. 18s.).

1403* Wallace, D. B.
Developments in Farm Management Advisory Work in the Eastern Counties.
J. Agric. Econ. Soc. 1957, **12,** 300–26.

This paper traces the results of five years' advisory work in the Eastern Counties. The first section is a general survey of the number and types of requests received—mainly from full-time farmers with reasonable experience. An analysis of those with poor returns showed that high costs rather than low output were more commonly the reason for low profits. But more requests were received from farmers who required managerial advice or help with policy decisions, the preponderance being of the latter type and involving some budgeting. Note is taken of those cases where sufficient records were available to show whether advice was successful in raising farm incomes by more than the general trend observed on other farms and reasonable results were recorded for farms other than those with a high proportion of pigs and poultry. The remainder of the paper deals with future developments. Apart from routine maintenance of standards and assistance with difficult cases, it is suggested that research could be turned towards policy problems and use made of small surveys to establish " modal " farms which could in turn be used to budget changes and study probable results of different approaches. Results of two or three such studies are mentioned and one project described in detail.

1376* Wallace, D. B. & Vincent, S.
System and Yield Indices in the Eastern Counties.
J. Agric. Econ. Soc. 1957, **12,** 230–4.

A short note showing the influence of intensity and yield on farm income. The connection is established by means of a multiple regression of farm income on yield index, system index and size of farm. The conclusion was drawn that variations in system and yield indices accounted for 25% of the variations in farm income. Within this limit a 10% rise in system index or 6% rise in yield index would raise farm income by £1 per acre. As it is usually easier to raise yields than intensify production on existing farms (except for the inclusion of more pigs and poultry) advisory work should be biassed towards greater technical efficiency.

WHETHAM, E. H. & ROYCE, C.

A Record of Agricultural Policy, 1954–1956. Pp. 64.

Fm Econ. Br. Occ. Pap. No. 3, 1957. 4s. Post Free.

A further contribution to the record of agricultural policy, administration and statistics. Earlier publications covered the periods 1947–1952, 1952–1954.

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1408* MACKNESS, R. A. **Outlook for Beef.** *Eastern Daily Press.* 22nd, 29th Dec., 1956; 5th 12th, 16th Jan., 1957.
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STURROCK, F. G. **Full Employment—the Managerial Problem.** *Agric. Rev., Lond.* 1956, **1** (11), 27–32.
WALLACE, D. B. **Counting the Cost.** *Fmrs Wkly.* 1957, **46** (19), 39, 41.
1373* WALLACE, D. B. **Sixty Acres in Search of a Profit.** *Fmrs Wkly.* 1957, **46** (6), f-g.
WALLACE, D. B. **Where Does the Money Go.** *Brit. Sug. Corp. Agric. Staff Conf.* 1956, 15–9.

AGRICULTURE

ENGLEDOW, F. L.

Report on the Tea Research Institute of East Africa.

Pp. 48. Nairobi, 1957.

The report reviews the field of research of tea in East Africa in relation to present needs and future developments. A considerable area is climatically and in soil character suitable for tea-growing but not all of this could be made available and not all has been studied in detail. In considerable parts of the potential tea growing region rainfall, both in total amount and in distribution, is likely to be limiting to economic production.

The tea bush population of East African territories is even more mixed genetically than in the older tea areas of the world and selection with commercial use of colonial material in mind is the most necessary immediate development in research.

Practical views about the need for shade trees in tea growing in East Africa are diverse and it is highly desirable that the complex influences of shade on tea should be investigated.

The use of fertilisers is demonstrably advantageous, but as in many parts of tropical Africa unexpected lack of response to one or other of the common plant food elements is encountered. This failure is connected in some cases with available soil moisture, which in turn is markedly influenced by mulching.

The quality of East African tea presents a number of problems, the most obscure of which is difficulty in " fermentation " of the leaf from some estates.

A new site for the Tea Research Institute of East Africa is about to be secured and the equipment and work of this Station are discussed.

ENGLEDOW, F. L.

Reflections on the Future.

Golden Sheaf. 1957, **9 (3)**, 6–9.

MANSFIELD, W. S.

The University Farm, 1956.

Golden Sheaf. 1957, **9 (3)**, 13–15.

ANIMAL BREEDING AND GENETICS

1382* CLOUGH, M. & COCK, A.G.

Variability of Inbred and Incross Chickens.

Nature, Lond. 1957, **179,** 1030–1.

The variability of two highly inbred lines of White Leghorns, I and C, has been compared with that of their F_1 incrosses. The incrosses are consistently less variable in body weight at 3, 6 and 12 weeks of age, and in age at production of first egg. In collaboration with other workers, tests are being conducted to discover how far incrosses, by yielding more uniform results than commercial strains of chicken, may be of value in bioassay and similar experiments.

RYLE, M.

Studies on Possible Serological Blocks to Species Hybridization in Poultry.

J. Exp. Biol. 1957, **34,** 365–77.

It is suggested that normal heteroantibodies may contribute to the difficulties of species hybridisation by damaging heterologous spermatozoa and/or by reducing hybrid embryonic viability.

Techniques are described for titrating yolk antibody and for agglutination tests with fowl spermatozoa.

Plasma samples from several breeds of chickens were titrated with turkey erythroctyes in order to study the variability of normal heteroagglutinin titres.

Turkey spermatozoa were agglutinated *in vitro* by chicken plasma. Absorption tests showed that the same antigens, reacting with the normal heteroagglutinin of chicken plasma, occur on turkey spermatozoa and turkey erythrocytes. Further work is required on the agglutination of chicken sperm by turkey plasma.

Low titres of anti-turkey-erythrocyte agglutinin in the blood of domestic hens did not promote interspecific fertility. Immunisation of domestic hens with the erythrocytes of the cockerel with which they were mated did not induce infertility. It is nevertheless considered that an investigation of normal incomplete antibody in relation to inter- and intraspecific fertility might prove fruitful.

Normal heteroagglutinins occur in turkey and chicken yolk. The titre of anti-turkey agglutinin in chicken yolk is very close to that in the hen's plasma.

Antigens reacting with the normal heteroagglutinin of turkey plasma appear on chick embryo erythrocytes after 4–5 days' incubation; there seems to be little quantitative increase thereafter. They occur on both primitive and definitive erythrocytes.

Normal anti-turkey agglutinin derived from the egg yolk was detected in the blood plasma of a few chick embryos after 13 days' incubation or more.

The latter results are discussed in relation to other published work both on the effects of antisera on embryogenesis and on the ontogeny of antigenic properties.

OTHER PAPERS

COCK, A. G. **Exploiting Hybrid Vigour in Poultry Breeding.** *Fmrs Wkly.* 1957, **46** (17), 109.

HAMMOND, J. **Pig Recording and Progeny Testing.** *Annu. Rep. Nat. Pig Rec.* 1955–6, **2**, 4–5.

PEASE, M. S. **Autosexing Breeds at Cambridge.** *Autosex. Annu.* 1957, 2–4.

POMEROY, R. W. **Progeny Testing of Pigs.** *Cattle Breed.* 1956 (9), 8–9.

ANIMAL NUTRITION

1377* BARBER, R. S., BRAUDE, R., MITCHELL, K. G., ROOK, J. A. F. & ROWELL, J. G.

Further Studies on Antibiotic and Copper Supplements for Fattening Pigs.

Brit. J. Nutr. 1957, **11**, 70–9.

Seventy-eight individually fed Large White fattening pigs, 8½–11 weeks old at the beginning of the two experiments carried out, were used to compare the effects of dietary supplements of either copper sulphate (0·1%), oxytetracycline (10 g/ton), chlorotetracycline (about 20 g/ton as Aurofac 2 A), a fermentation product, Vigofac (10 lb./ton) or a mixture of Vigofac and oxytetracycline on rate of gain, efficiency of food utilisation and rate of food consumption.

Information was also obtained on the effect of dietary copper on the copper content of various tissues and organs, and of copper and chlorotetracycline supplements on the weight of various organs of the pig.

In a third experiment involving eight individually penned pigs, the effect of diets containing 0·5 and 1·0% copper sulphate was investigated.

Copper sulphate, oxytetracycline and chlorotetracycline all significantly and similarly increased growth rate and rate of food consumption; the last also significantly improved the efficiency of food utilisation. Vigofac had no significant effect on the performance of the animals. Combined results for both experiments showed that copper sulphate improved food conversion by 3·9%, an effect that approached significance at the 5% level.

Of all carcasses, 76·6% were graded A at the bacon factory. There was a reduction in triple-A carcasses from the copper-fed pigs but this reduction was not significant.

The liver copper of the copper-supplemented pigs varied from 25·1 up to 315·2 mg/kg wet material, the mean value of 109·4 being eight times that of the controls. Smaller increases in the other tissues and organs from the supplemented pigs were observed.

There was a tendency for chlorotetracycline to reduce gut and liver weight. Copper showed a similar, although less marked, effect on these organs. Chlorotetracycline also significantly reduced spleen weight.

Food intake of pigs offered meal containing either 0·5 or 1·0% copper sulphate rapidly fell to a very low level and the pigs failed to gain weight. All pigs resumed satisfactory growth and food intake immediately the copper supplement was reduced to 0·1%, or omitted from the diet.

The results obtained are discussed in relation to the known toxic effects of feeding of very high amounts of copper to sheep and cattle.

1367* BRAUDE, R. & ROWELL, J. G.

Labour Saving in Feeding of Fattening Pigs.

J. Agric. Sci. 1957, **48**, 322–5.

In a co-ordinated experiment involving twenty centres and 558 pigs it was found that the growth rate, efficiency of food conversion and carcass quality of the pigs were not affected when one afternoon meal was omitted each week throughout the fattening period, provided the amount of meal thus saved was distributed between the remaining feeds during each week.

Limited evidence is presented to show that similar results may be obtained when two afternoon feeds are omitted each week.

CARPENTER, K. J.

Chemical and Biological Assay of Lysine in Foods.

Abstr. Pap. 4th Int. Congr. Nutr., Paris, 1957, 154–5.

The value of protein-rich foods in supplementing diets where lysine is the limiting amino-acid is often lower than expected from their lysine content. Processed foods can be seriously over-valued. Conventional assays begin with acid-hydrolysis that liberates lysine molecules " bound " through the ϵ–NH_2 groups. Reacting fluoro-dinitrobenzene (FDNB) with free ϵ–NH_2 groups in intact proteins, and estimating DNP–lysine after acid hydrolysis gave closer correlation with nutritive value for chicks.

Conventional and FDNB analyses for 6 animal protein preparations are now compared with results from biological assays with rats. The basic design was a balanced 2–point assay suitable for statistical analysis. The basal diet, fortified for palatability and possible " unknown growth factors ", included wheat gluten, skim milk, zein, sesame meal and six supplementary amino-acids.

The food alone, and with 0·24% added l-lysine, gave gains of 1·0 and 4·5 g./day respectively. Intermediate supplements showed linear responses. For the 12 test groups (6 materials × 2 levels) the response was predicted more closely ($P<0{\cdot}001$) by the FDNB measure of their lysine content than by the conventional microbiological assay. Severely heated materials gave much smaller responses than expected from conventional analysis. In some cases even the FDNB method slightly under-estimated the apparent degree of damage. Heating casein with glucose reduced rat and FDNB values by 40% without changing the lysine content by conventional analysis.

1393* CARPENTER, K. J. *and others*†

Fish Products as Protein Supplements to Cereals.

Brit. J. Nutr. 1957, **11,** 162–73.

A number of dehydrated fish products were tested as supplementary proteins to cereals by the standard ' gross protein value ' technique with chicks. Those prepared for human consumption proved superior to the casein that was used as the standard.

Commercial fish meals gave values approximately 10% below those of preparations made by low-temperature drying processes.

The value of vacuum-dried cod fillets, packed in nitrogen at 2–3% moisture content, was not significantly reduced by holding the product at 100° for 31 h. despite considerable browning and formation of ammonia.

Similar fillets raised to 11% moisture content and held at 105° for 36 h. showed reduction of approximately 28% in nutritive value.

The addition of lysine to the heat-damaged fillets and to a commercial fish meal raised their value; no such effect was obtained with high-quality vacuum-dried fillets.

A chemical measure of ' available lysine ' obtained by reaction of the test materials with fluorodinitrobenzene and subsequent estimation of ϵ-dinitrophenyl-lysine after hydrolysis showed a close relationship with the biological results.

† Work carried out at the Rowett Research Institute, Bucksburn, Aberdeen.

1389* TAYLOR, J. H. & ROWELL, J. G.

Effect of Various Levels of Penicillin and Chlortetracycline in the Diet of Fattening Pigs.

Brit. J. Nutr. 1957, **11,** 111–6.

Experiments were carried out to investigate the effect on the rate of growth and food-conversion ratio of fattening pigs of various levels of penicillin and chlortetracycline in their diet. Rations were used in which antibiotic was added at the rate of 0, 2, 4, 8, 16, 32, 64, 128 and 256 g/ton food. The experiments were replicated three times and involved 279 pigs.

The regressions of growth rate and of food conversion on log dose were significant; the differences of the regressions between antibiotics were not significant.

Neither growth rate nor food conversion differed significantly between antibiotics at any dose level.

WOODMAN, H. E.

Rations for Livestock. 14th ed.

Bull. Minist. Agric. Lond. **18,** 1957. (H.M. Stat. Office, 5s. 6d.)

This edition has been prepared, with minor alterations, from the text written by the late Dr H. E. Woodman shortly before his death.

OTHER PAPERS

1401* CARPENTER, K. J. **Intensive Rations for Laying Hens.** *Agriculture, Lond.* 1957, **64,** 265–70.

ANIMAL PHYSIOLOGY AND PRODUCTION

1350* CAMPBELL, R. C., DOTT, H. M. & GLOVER, T. D.

Nigrosin Eosin as a Stain for Differentiating Live and Dead Spermatozoa.

J. Agric. Sci. 1956, **48,** 1–8.

The proportion of stained spermatozoa in a ram semen-nigrosin-eosin mixture has been found to increase with the time of exposure to the stain. Five minutes is considered to be a suitable interval for practical use.

The value obtained for the proportion of dead cells can be considerably affected by the selection of fields that are easy to count; fields should be chosen at random.

The variation between counts on the same smear is much larger than that expected for binomial proportions. This may be due partly to the ' clumping ' of the dead spermatozoa and partly to the difficulties of interpretation caused by the presence of many partially stained cells.

A significant difference was found between the estimates of the proportion dead obtained by the two experimental workers; this is thought to be due to a difference of interpretation of ' stained ' and ' unstained '.

Tables are given by which to determine the approximate accuracy of counts made on a range of numbers of spermatozoa, smears and subsamples, separate tables being necessary for ram, boar and bull semen.

1388* Cooper, D. M. & Rowell, J. G.

Laboratory Prediction of the Fertilizing Capacity of Cock Semen.

Poult. Sci. 1957, **36,** 284–5.

Laboratory tests cannot differentiate between collections within cocks.

By measuring any one of resazurin reduction time, initial pH or percentage dead sperm, it is possible to identify cocks whose semen has an abnormally low fertilising capacity. After allowing for variations in resazurin reduction time (pink), variations in fertility between cocks are considerably reduced. The small residual variations can to some extent be explained by percentage dead sperm.

In view of the small number of groups of cocks in this experiment, the conclusions reached are somewhat tentative. A further experiment is proposed, in which individual cocks will be studied and fewer laboratory tests used.

Hammond, J. (Ed.)

Progress in the Physiology of Farm Animals. Vol. 3.

Pp. v + 743–1043. *Butterworths Sci. Publ., London,* 1957. 50s.

1407 *Hammond, J.

Recent Progress in the Physiology of Animal Reproduction. Pp. i–ix.

Contr. to Recent Work in Domestic Animal Breeding Work. Pp. 429.

Minist. Agric. Chugoku Exp. Sta., Japan, 1957. (Main text in Japanese).

Hammond, J.

Report to the Government of India on Animal Production in the State of Bombay. Pp. 19.

FAO Rep. **480,** Rome, 1956.

Hammond, J.

Report to the Government of the Sudan on Livestock Improvement. Pp. 23.

FAO Rep. **626,** Rome, 1957.

Hammond, J.

Reproductive Hormone Balance and Sterility.

Ann. Ostet. Ginec. 1956, **78,** 28.

From a comparison of the different species of farm animals with regard to the hormone balance of FSH and LH in the anterior pituitary and so of oestrogen/progesterone output, it is evident that this influences the details of the oestrous cycle, such as the duration of oestrus, time of ovulation and the occurrence of " silent heat ". There is also a relation between these hormone balances and the types of sterility which are most frequent in the species.

1349* Hunter, G. L.

Maternal Influence on Size in Sheep.

J. Agric. Sci. 1957, **48,** 36–60.

The influence of the maternal environment on the size of lambs from birth to 8 months has been studied by reciprocally crossing the large Border Leicester and the small Welsh Mountain breeds of sheep and by transferring fertilised eggs between ewes of these breeds.

Ewes which lambed later in the spring gained more weight during the last 6 weeks of pregnancy than did the earlier-lambing ewes. The birth weight of the lambs was not, however, affected by either the date of lambing or the ewes' gain in weight during the last six weeks of pregnancy.

Significant breed differences in gestation length were recorded; these were 144·7 days for Border Leicester and 147·1 days for the Welsh Mountain. Border Leicester ewes carrying pure-bred Welsh lambs had an average gestation of 149·6 days, while Welsh Mountain ewes carrying pure-bred Border Leicester lambs had an average gestation of 146·0 days. From the births of ' transferred ' lambs, it appeared that the genetically smaller lamb was a cause of a longer gestation period. On the other hand, within groups, both live weight and length of ' cannon bone ' of the lambs at birth increased when the gestation period was longer.

The maternal environment affected foetal growth when the genotype for size of the foetus was different from that of the mother. The mean live weight and ' cannon bone ' length of cross-bred lambs born to Border Leicester ewes were 1·08 lb. and 0·37 cm. greater at birth than those of cross-bred lambs born to Welsh ewes. Comparable

figures for the maternal influence from the results of transferring eggs from one breed to the other were 1·96 lb. and 0·33 cm. On the other hand, within breeds, there was no effect on the size of the lambs at birth of variations in the size of the ewes. The length of the ' cannon bone ', which grows relatively rapidly during the early stages of growth (an early-maturing part of the body), was less influenced by the maternal environment than the late-maturing live weight.

Mature ewes produced larger lambs at birth than young ewes. The mean differences at birth in weights and in lengths of ' cannon bone ' of the lambs born to young and mature ewes were 1·38 lb. and 0·31 cm. respectively.

From these and other experiments, the conclusions were drawn that: (i) the maternal influence on the size of young at birth is greater, in the larger species which have longer gestation periods, than the effect of the genotype of the young; (ii) the maternal organism competes with the foetus for nutrients, thus limiting the size of the young at birth ; and (iii) the maternal organism may also influence pre-natal foetal growth by means of some internal secretion or metabolic substance.

The amount of milk consumed by the lambs had a marked effect on their live weight gains during the first half but not during the second half of lactation. Variations in milk consumption by the lambs did not affect the growth in length of their ' cannon bones '. The influence of the post-natal maternal environment is largely exerted through the milk yield of the ewe and causes of variation in this milk yield were reflected in the post-natal maternal influence estimated in these experiments.

The total milk yield of ewes was affected by their date of lambing, that of late-lambing ewes being less than the yields of ewes which lambed earlier in the season.

The milk yield of Border Leicester ewes was greater than that of Welsh Mountain ewes during the first half of lactation, but differences in the level of production later in lactation were small. The milk yield of ewes rearing twin lambs was greater, throughout lactation, than that of ewes rearing singles. Mature ewes maintained a higher level of milk production throughout lactation than young ewes; the difference in yield was due to the fact that there was a higher degree of persistency of production on the part of the mature ewes.

By 8 months of age the genotype of the lamb was the most important factor affecting its size. The maternal influence on the early-maturing ' cannon bone ' length disappeared at 7 months; at 8 months, 17% of the total variation in live weight was still due to the maternal influence, but it seemed probable that the effect of this influence would further diminish to insignificance by the time the lambs were about 2 years of age.

1385* Labban, F. M.

Hairiness in Wool and a Method for Selection Based on the Nature of the Fibres and the Distribution of Halo Hairs of the Lamb's Tail.

J. Agric. Sci. 1957, **49**, 1–18.

Hairiness in wool of Suffolk sheep as a fault was found to be associated with other defects like coarseness of wool fibres, hairiness of the britch, and the occurrence of pigmented fibres. The presence of these various defects was studied in the lamb's tail at docking time, and subsequently evaluated and correlated with the fleece.

The tails were graded according to the nature of the fibres and the spread of halo hairs from the tip to the base into four principal grades which by further subgrading could be made into seven grades. The results were as follows:

There was wide variability in grades of tails within each flock.

Average grade of tails followed in general the mean quality of the adult fleece.

When Border Leicester were crossed with Welsh Mountain the tails of the two reciprocal crosses were found to be of hairy type of tail and nearly like the Welsh Mountain type.

The percentage of coloured tails in the least hairy grades was found to be inversely related to the quality of the tail grade and indirectly to the fleece quality.

The diameter of the wool fibres on the base of the tail is highly correlated with the diameter of fibres from the britch regions or mean fibre diameter from four regions of the body (mid-shoulder, mid-side, hip and britch).

The mean diameter of the wool fibres obtained from four different parts of the tail was correlated with those of the britch regions only.

The diameter and variability of fibres increased from shoulder to britch in the body and from base to tip in the tails.

The britch and tails of two groups of sheep, one group characterised by coarse and the other by fine britch and tail wool, were studied histologically. There were significant or highly significant differences in the following characteristics in the britch of the two groups: (*a*) total number of follicles, (*b*) primary follicles with no medulla, (*c*) total number of secondary follicles, (*d*) secondaries with no medulla, (*e*) secondaries with large medulla. The only type of follicle where a significant difference was found in the tail was in the number of secondary follicles with no medulla.

The following follicle types in the base of the tails and britches were found to be significantly correlated: (*a*) total number of follicles, (*b*) secondary follicles, (*c*) primary follicles with no medulla, (*d*) secondary follicles with no medulla ,and (*e*) secondaries with small medulla.

It was concluded from the above results that the lamb's tail can serve as a useful guide for the evaluation of the adult fleece, and a method has been described for selection against hairiness and indirectly, therefore, the other associated defects. This method is based on the principle of the spread of halo hairs in the tail.

1386* Labban, F. M.

Effect of Growth Hormone on Wool Follicles.

J. Agri.. Sci. 1957, **49,** 19–25.

Five pairs of Suffolk twin lambs were used and one of each pair was injected twice daily with 2 mg. of a growth hormone preparation for 2 weeks.

Treatment was begun when they were between 3 and 4 weeks old, the total number of follicles in the Suffolk not being complete until 6 weeks old. Skin samples were taken at the beginning and end of the experiment.

It was found that in 0·25 sq. cm. of skin the total number of primary follicles was reduced from the beginning to end of the experiment in both control and treated groups, probably because of the expansion of skin area during that time. While the total number of secondary, ' news ' and ' plug ' follicles was also reduced in the control group, they were increased in the treated group.

Since the secondary to primary follicle ratio was 5·3: 1 for the treated group as compared with 4·5: 1 for the controls it is concluded that growth hormone increases the number of secondary follicles which develop during the early weeks of post-natal life.

1387* Labban, F. M.

Effects of l-Thyroxine on Sheep and Wool Production.

J. Agric. Sci. 1957, **49,** 26–50.

Three experiments were carried out in this study to investigate the effects of L-thyroxine on sheep and wool production. In the first experiment L-thyroxine was orally administered to ewe lambs from weaning time for a period of 48 weeks. In the second experiment, ten uniform yearling ewes were selected and were randomly distributed into two groups of five; one group was fed daily 7 mg. l-thyroxine per ewe for 7 weeks from 1 April 1954. In the third experiment l-thyroxine was fed as a supplement to lactating ewes over the second to the sixteenth week of lactation at the rate of 7 mg. daily per ewe.

Differences in both body weight and rectal temperature between the experimental and control groups were not statistically significant. The treatment had also no effect on the body weight of the ewes during lactation.

Wool growth, as measured by the weight of keratine production per unit of surface area, was increased significantly during the period of thyroid treatment. This increase in wool production was due to an increase in the length of the wool fibres but not to any observable increase in the diameter of the fibres. This effect is different from that produced by a high plane of nutrition where extra wool production is characterised by increase in both length and diameter.

It was observed that the treated ewes exhibited hypersexual activities characteristic of male behaviour, i.e. jumping and mounting other animals.

There was a significant increase in the rate of milk secretion over the period 2–8 weeks. This increase was reflected in an improved live-weight increase of the lambs which were suckling these treated ewes. The difference in milk yield between treated and untreated ewes was not maintained over the nine to ten weeks period of the lactation.

As a result of these studies it has been established that the normal milking performance of Border Leicester × Scotch Blackface ewes is high as compared with that of other breeds or crosses reported in the literature. The shape of their lactation curve suggests, however, that it is possible that after the eighth week of lactation the ewes may become competitors with their lambs for available grazing. Expressed in another way ewes become less efficient as converters of their food into milk for lambs, for which milk is becoming proportionately a less important component of the diet. This finding raises the question of the possibilities of providing creep grazing or supplementary feeding for lambs so that their growth potential is fully realized. Alternatively, there may, under farm conditions, be grounds for weaning lambs at about 12 weeks so that they may have preferential treatment in regard to available grazing rather than to adopt customary weaning at about 16–18 weeks of age.

It has been established that a close relationship exists between the milk yield of dams and the growth rate of their lambs under normal grazing conditions. Because of this strong relationship a regression formula has been tentatively advanced which may permit workers to select ewes for milk yield on the basis of the live-weight gain of their lambs.

1404* Rowell, J. G. & Cooper, D. M.

Relation Between Fertility in the Fowl and the Dilution Rate of the Semen Using a Glycine Diluent.

Poult. Sci. 1957, **36,** 706–12.

An experiment was carried out to test the effect on the fertilising capacity of cock semen of dilution with glycine in distilled water: the dilution rates were 0, 1 : 1, 1 : 1·5, 1 : 2·5 and 1 : 3·38. There were 36 females for each treatment.

Within the range 1 : 1 to 1 : 3·38, fertility (transformed from percentages to angles) decreased linearly as the rate of dilution of the semen increased.

The rate of decrease was the same for all collections.

Fertility corresponding to semen diluted 1 : 1 was sensibly the same as that corresponding to undiluted semen.

The results of this and previous experiments suggest that the principle cause of decreasing fertility with increasing dilution rate is the decreasing number of live spermatozoa inseminated. Only small increases in fertility can be expected if more than 170 million live spermatozoa are inseminated.

OTHER PAPERS

1355* HAMMOND, J. **Evaluating a Beef Carcass by Cutting.** *Hereford Breed. J.* 1956, **3,** 118–9.
1381* HAMMOND, J. **Fertility and the Production of Fat Lambs.** *Agric. Rev., Lond.* 1957, **2** (1), 23–7.
1390* HAMMOND, J. **Growth of the Pig. Part I. What is Required for Bacon.** *Pig Progr.* 1957, **1** (3), 8–9.
1395* HAMMOND, J. **Growth of the Pig. Part II. Changes in Body Proportion.** *Pig Progr.* 1957, **1** (4), 6–7.
1405* HAMMOND, J. **Growth of the Pig. Part III. Effect of Feeding Methods.** *Pig Progr.* 1957, **1** (5), 14–15.
1357* POMEROY, R. W. **Factors Affecting the Quality of Meat.** *Agric. Rev., Lond.* 1956, **2** (7), 35–8.

CROP HUSBANDRY

1366* BARKER, M. G., HANLEY, F. & RIDGMAN, W. J.

Studies on Lucerne and Lucerne-grass Leys. IV. Effect of Systems of Grazing Management on Persistence of a Lucerne-cocksfoot Ley.

J. Agric. Sci. 1957, **48,** 361–5.

Experiments to assess the effects of grazing management on the persistence of a lucerne-cocksfoot ley are described and the results discussed.

The work confirms the general opinion, based on other experiments in which lucerne was defoliated by cutting, that frequent defoliation causes a reduction in the persistence of the lucerne.

Defoliation at 8-weekly intervals maintained a satisfactory balance between the sown species in a lucerne-cocksfoot sward, irrespective of whether defoliation was by cutting or by grazing or by a combination of the two.

Grazing at 4-weekly or 2-weekly intervals led to serious reductions in the proportion of lucerne in the sward.

The provision of a rest period, either early or late in the growing season, had little effect on the amount of lucerne present after 2 years on plots subjected to grazing at 4-weekly or 2-weekly intervals.

1402* HANLEY, F., RIDGMAN, W. J. & BARKER, M. G.

Effect of Leys on Soil Fertility. I. Effect of Management of Clover Aftermath on the Yield of the Succeeding Wheat Crop.

J. Agric. Sci. 1957, **49,** 251–7.

A series of experiments designed to compare the effects on the succeeding wheat crop of five different methods of treating the aftermath of a Broad Red Clover ley is described and the results discussed.

There was little consistent difference in the effects of using the second crop for hay, for grazing or for green manure by ploughing it in. Bastard fallowing immediately after the first hay crop and taking the second crop for seed both showed large seasonal fluctuations in their effects, but there was insufficient evidence to show if these were due to seed-bed differences.

In no season was taking the second crop for hay outyielded by any other treatment.

CROP PESTS AND DISEASES

1378* CRUICKSHANK, I. A. M. & SWAIN, T.

Study of Phenolic Compounds in Oil-Flax (*Linum usitatissimum*).

J. Exp. Bot. 1956, **7,** 410–5.

The complexity of the phenolic constitution of flax tissues is demonstrated. A method for the purification of phenolic compounds and their estimation from a complex mixture of these substances in plant extracts is described together with the use of semi-micro paper chromatography and paper electrophoresis for their identification.

Chlorogenic acid and an isomer of this acid are shown to be present in four linseed varieties. The concentration of chlorogenic acid and the ratio of chlorogenic acid to total phenolics is studied in relation to disease resistance.

1360* DUDDINGTON, C. L., JONES, F. G. W. & MORIARTY, F.

The Effect of Predacious Fungus and Organic Matter upon the Soil Population of Beet Eelworm, *Heterodera schachtii* Schm.

Nematologica. 1956, **1,** 344–8.

In microplots containing soil very heavily infested with beet eelworm (*Heterodera schachtii* Schm.), an experiment was undertaken to test the effect of heavy doses of fungal mycelium and organic matter upon the yield of beet and the final eelworm population. Both fungus (*Dactylaria thaumasia* Drechsler) and organic matter (bran)

increased the yield of beet. Fungus had no significant effect upon the final cyst population but organic matter caused a significant depression. Neither treatment affected the final egg population. It is not known whether the organic matter lowered the cyst population by enhancing the effect of predacious fungi in the soil or in some other way, e.g. by increasing the micro-fauna and flora, thus leading to increased competition for oxygen, which might reduce the hatch and activity of beet eelworm larvae.

1359* Duddington, C. L., Jones, F. G. W. & Williams, T. D.

An Experiment on the Effect of a Predacious Fungus upon the Soil Population of Potato Root Eelworm, *Heterodera rostochiensis* Woll.

Nematologica. 1956, **1**, 341–3.

A microplot experiment was made to test the effect of a predacious fungus (*Dactylaria thaumasia* Drechsler) and three types of organic matter (leaf mould, compost and chopped cabbage) upon potato root eelworm (*Heterodera rostochiensis* Woll.). The initial population of the eelworm was low and the treatments were without effect upon the yield of potatoes or upon the final cyst and egg populations.

1358* Dunning, R. A.

A Diurnal Rhythm in the Emergence of *Pegomyia betae* Curtis from the Puparium.

Bull. Ent. Res. 1956, **47**, 645–53.

There is a clear diurnal rhythm in the emergence of the Beet Fly, *Pegomyia betae* (Curt.), from the soil, peak emergence occurring daily between 06. and 07. hr., when the soil temperature at a depth of 2 in. and the air temperature are at about their minimum, or are just beginning to rise, and humidity is at its maximum. In two observations on the emergence of the first generation, 82·2 and 85·6 per cent. of the daily emergence occurred before 08. hr., whilst in two observations on the emergence of the adults of the non-diapausing part of the second generation, 79·1 and 76·3 per cent. of the daily emergence occurred before 08 .hr.

During the period of emergence of flies from a batch of puparia, the rhythm was most marked at the time of peak emergence, and was less marked at the beginning and end of the emergence period.

The rhythm of emergence was much less pronounced, and the peak occurred later in the day, when puparia were kept at constant temperature from two days before the first flies emerged.

Experiments led to the conclusion that the fly reaches the soil surface within one hour of leaving the puparium at a depth of 2 in. in soil, and that the processes of wing expansion and cuticle tanning are probably controlled by a nervous mechanism.

The possible initiators of the diurnal rhythm are discussed. It is concluded that the results obtained could be explained by the suggestion that the rhythm is induced by the effect of temperature or light fluctuation at some time before the late pupal stage, or that it might be inborn in the species, and that it is further regulated by temperature variation at the time of emergence. Further work will be necessary before the suggested explanation can be shown to be valid or otherwise.

Dunning, R. A.

Beet Stem Eelworm.

Nematologica. 1956, **1**, 189–91.

The symptoms of seedling attacks are described, and details given of the race of *D. dipsaci* concerned. The reason for some field outbreaks in 1953 is not clear, seedborne infestation being of little importance. It is suggested that serious autumn crown canker is a result of spring invasion.

Dunning, R. A.

Mirid Damage to Seedling Beet.

Plant Path. 1957, **6**, 19–20.

Damage caused by mirid nypmhs on sugar beet foliage is common and well known; whilst seedling damage was not noticed on a widespread scale until 1956. The characteristic symptoms observed are described and illustrated. In young seedlings the growing point was frequently killed, leading to thickening of the cotyledons and development of axillary buds, finally producing a stunted and multi-crowned plant. In older seedlings the bugs feeding caused necrosis and severe distortion of the heart leaves. There was no evidence of migrating nymphs and all the symptoms suggested that over-wintering adults were responsible.

Engledow, F. L.

Opening Address.

Proc. 2nd Int. Plant Prot. Conf., Fernhurst, 1956. Pp. 13–18. (Butterworths Sci. Publ., London, 1957. 50s.).

1354* Jones, F. G. W. & Moriarty, F.

Further Observations on the Effects of Peas, Beans and Vetch upon Soil Population Levels of Pea Root Eelworm, *Heterodera göttingiana* Liebscher.

Nematologica. 1956, **1,** 268–73.

In microplot and garden plot experiments, peas caused marked rises in cyst and egg populations of pea root eelworm. Vetch doubled the number of cysts but gave only a small increase in eggs. Field bean also nearly doubled the number of cysts but barely maintained the egg population. Longpod and Windsor beans caused relatively small increases in cyst numbers and reduced the egg populations. Despite the high initial egg populations of some plots, no symptoms of pea ' sickness ' appeared in 1955, probably because of the cool, moist weather during the growing period and possibly also because of the nitrogenous fertiliser applied to the plots.

1361* Jones, F. G. W. & Moriarty, F.

A Preliminary Experiment on the Effect of Various Cereals on the Soil Population of Cereal Root Eelworm, *Heterodera major* O. Schmidt.

Nematologica. 1956, **1,** 326–30.

In an experiment with microplots, oats and barley caused greater increases in cereal root eelworm populations than did wheat. The highest population followed barley, variety Herta. A slight decline in population followed barley, variety Kron, and wheat variety Bersée, both of which gave final populations significantly lower than most of the other cereal varieties tested. Because of the previous uniform treatment of the plots, population changes were adequately measured by cyst counts which gave greater precision than the egg counts.

1392* Shepherd, A. M.

Development of Beet Eelworm, *Heterodera schachtii* Schmidt, in the Wild Beet, *Beta patellaris.*

Nature, Lond. 1957, **180,** 341.

Observations have shown that, at the rate of infestation of 20 larvae/gm soil, about 65% of the larvae of beet eelworm invading the roots of the wild beet, *Beta patellaris*, develop to the 3rd larval stage and about 7% reach maturity, becoming males. No females have been found in the roots of this species.

1353* Wallace, H. R.

Seasonal Emergence of Larvae Cysts of the Beet Eelworm *Heterodera schachtii* Schmidt.

Nematologica. 1956, **1,** 227–38.

Field experiments in 1954 and 1955 showed that there was a high rate of larval emergence from cysts of the beet eelworm during April and May followed by a low emergence rate from June to September. It is shown that low soil moisture content was probably the chief factor inhibiting emergence during the summer months. Larval emergence probably does not occur in soil where the pressure deficiency exceeds 150 cm of water. Recordings of pressure deficiency in 4 soil types during 1955 showed that from June to September the pressure deficiency was mostly above this level. A comparison of larval emergence from cysts within and between soil crumbs was made. At least 50 per cent of the cyst population occurred within crumbs, but the rate of larval emergence from these cysts was very low. It is suggested that when counts of cyst contents in soil are made, a dispersing agent such as " Calgon " should be used to release cysts enclosed in soil crumbs.

OTHER PAPERS

DUNNING, R. A. **Use of Modern Insecticides in the Control of Some Beet Pests.** *Brit. Sugar Corp. Agric. Staff Conf.* 1956, 10–14.

1397* RIBBANDS, R. **The Scent Language of Honey Bees.** *Discovery.* 1955, **16,** 22. *Rep. Smithson. Instn.* 1955 (1956), 369–77.

PLANT BREEDING AND GENETICS

Ashton, T.

Genetical Aspects of Seed Storage. Pp. 34–8.

Contr. to Bull. 43, Commonw. Bur. Pastures.

(*Commonw. Agric. Bur., Farnham,* 1956. 20s.)

Work on the inheritance of longevity and on mutation in ageing seed is surveyed. It has been shown that risk of heritable changes increases with length of storage, but, as pointed out, relatively little is yet known of the effects of pre-storage seed treatment upon viability and hereditary constitution.

1364* Engledow, F. L., Bell, G. D. H. & Lupton, F. G. H.

A Study of the Value of Repeated Backcrossing of a Pentaploid Hybrid of *Triticum vulgare* (Cult. var. Little Joss) and *T. turgidum* (Cult. var. Rivett).

J. Agric. Sci. 1956, **48,** 250–7.

Selections from a cross of varieties of *Triticum vulgare* and *T. turgidum* have been backcrossed repeatedly to the *turgidum* and *vulgare* parents and selections of *turgidum* and *vulgare* type respectively made within each series.

The yield and morphological stability of *turgidum*- and *vulgare*-type selections from the straight cross have been compared with those of selections backcrossed up to four times to *T. turgidum* and *T. vulgare* respectively.

In the case of backcrosses to *T. turgidum* the highest yielding selections have been derived from the most frequently backcrossed material, but the *vulgare*-type selections from the straight cross have outyielded those from the material backcrossed to *T. vulgare*.

An analysis of the yield components of the parents and of the most promising selections, in terms of ears per plant, spikelets per ear, grains per spikelet and 1000-grain weight, has shown no evidence of a combination of the characters determining the high yield of the parents in these high yielding selections.

1365* LAZENBY, A.†

The Problem of Assessing Strains. A Study in Grass-breeding Technique.

J. Agric. Sci. 1957, **48**, 294–304.

This paper reports a study of the behaviour of five strains of ryegrass (Devon Eaver, Irish, S.24 and New Zealand certified mother perennial ryegrass and H.1) under three different conditions of spacing and two types of management. Strain performances are compared on the basis of green and dry-weight data of total herbage, and green weight of sown strain contributions under the three techniques of evaluation.

Under both managements, the total annual production per unit area was greatest from broadcast and least from single-plant areas. Some individual cut yields were, however, greater than those from broadcast plots, with the drill-row production intermediate.

Yield differences between the four perennial ryegrasses were greatest as spaced plants and least in broadcast plots. Single plants and broadcast plots of H.1 were outstanding compared with the perennial strains. Under neither management were there significant interactions between strains and sowing method in 1952, though such interactions were detected in both cases during 1953.

The relative yield performance of strains under similar spacing conditions were almost identical under both managements.

† Work carried out at the Welsh Plant Breeding Station, Aberystwyth.

PLANT ECOLOGY

1348* LAZENBY, A.

Establishment and Growth of Wild Onion (*Allium vineale* L.) from Aerial Bulbils.

Proc. 3rd Brit. Weed Conf. 1956, **1**, 211–9.

The paper reports the following preliminary findings from box experiments :—

Competition from perennial and Italian ryegrass sown at the same time as the bulbils did not reduce significantly the number of onions which were able to become established but much the largest onions grew where there was no competition.

More onions established themselves, and a greater total weight of bulbs and offsets were produced in sand than in clay, although the individual onions harvested from the clay were significantly heavier than those removed from sand.

An increase in fertility status resulted in a reduction in the number of established plants, yet the largest onions were removed from the conditions of highest fertility, there being a linear response to increased nutrients.

Where the roothold of young plants was broken beneath the soil surface and the young plants replanted (series A) all survived. Constant root breakage retarded the plant's growth, yet the treatment carried out in mid-March—when the plants were very young—had a stimulating effect on shoot size. Plants left untouched after this initial disturbance grew bigger bulbs than did the controls.

In a second series of boxes, young plants were uprooted, left on the soil and surface watered. Effects of these treatments were more drastic than in series A. Stage of growth of the plants when uprooted was an important factor—the effect on plants disturbed in mid-June was slight compared with those uprooted earlier. A high proportion of plants disturbed once only, early in their life, made new root and shoot growth.

A third series of boxes had their onions uprooted but not watered. Plants pulled up in mid-March retained the green colour in their shoots for some time—4 to 5 weeks. Those pulled at the end of April immediately transferred all their food reserves into a small bulb. After four weeks exposure to greenhouse temperatures up to 90° F. some 60% of such plants sprouted again when suitable conditions were recreated. This figure fell to zero after eight weeks' exposure. All plants removed in mid-June survived eight weeks in conditions of high temperatures.

1379* LAZENBY, A.

The Value of Knowing Your Weed as an Aid in its Control.

Agric. Progr. 1955. **30**, 132–6.

Weed control is considered under the following headings :— some principles of plant competition, the behaviour of the weed plant itself, need for controlled experiments, and the value of experimental findings.

1370* Childs, E. C.

The Anisotropic Hydraulic Conductivity of Soil.

J. Soil Sci. 1957, **8**, 42–7.

When discussing soils with anisotropic hydraulic conductivity it is usual to assume for simplicity that the three directions in which the principal conductivities may be specified are mutually perpendicular, i.e. they may be taken as the axes of a system of rectangular cartesian coordinates. It is usually readily agreed that this assumption is plausible since the structural fissuring to which anisotropy is due is, in nature, predominantly horizontal and vertical. It is shown here that the assumed property is in no way dependent upon such restrictions of direction of the contributory fissures, but that provided the conductivities of the individual contributors themselves are characterised by mutually perpendicular axes, then any combination of the contributors in any directions results in a total conductivity which also has three mutually perpendicular axes.

1371* Childs, E. C., Collis-George, N. & Holmes, J. W.

Permeability Measurements in the Field as an Assessment of Anisotropy and Structure Development.

J. Soil Sci. 1957, **8**, 27–41.

Thirteen sites were examined and the permeabilities determined by a combination of the two-well (Childs) and the single-tube (Kirkham) methods. Anisotropy occurred in less than half of these sites. The range of permeabilities encountered was ten-thousand fold. Two of the clay soils have permeabilities comparable with those of gravelly sands.

An argument is presented for the use of permeability as an objective measure of structure in the field and the principal disadvantages of the permeability method are listed.

Variability in field structure is considered from the aspect of the ratio between the size of the well sample and the size of the structural units. Four cases of variability are interpreted in terms of their effect on the standard error and the asymmetry of results obtained by the two-well method. This interpretation is shown to allow of the assessment of field structure from the permeability results. When sub-units of structure and the experimental equipment have similar dimensions, individual determinations have questionable validity.

The method of calculating permeability and anisotropy from field data is given in an Appendix. A comparison of the field descriptions with the permeability results for the experimental sites indicates that qualitative profile differentiation does not always imply a change of permeability; neither can visual profile uniformity be taken to indicate uniform permeability.

1343* Childs, E. C.

Recent Advances in the Study of Water Movement in Unsaturated Soil.

Proc. VIth Int. Congr. Soil Sci. 1956(b), 265–74.

Examples taken from various agricultural and pedological fields show that it is important to have a physical theory of the development of soil moisture profiles. It is seen that the problem is in two parts, (*a*) the determination of the hydraulic conductivity of unsaturated soil as a function of moisture content and (*b*) the solution of certain equations, derived from Darcy's law, which have the character of the diffusion equation with modifications and with diffusivity dependent upon moisture content. Methods of solving these problems are surveyed down to the present time.

1375* McAleese, D. M. & McConaghy, S.

Studies on the Basaltic Soils of Northern Ireland. II. Contributions from the Sand, Silt, and Clay Separates to Cation-Exchange Properties.

J. Soil Sci. 1957, **8**, 135–140.

The cation-exchange capacities of soil separates, isolated by the International soda method and decantation from five basaltic soil profiles were determined by the neutral normal ammonium-acetate method of Schollenberger and Simon. The exchange capacities of the clays ranged from 41 to 60 m.e. per cent. The results suggest the presence of clays of the illitic type. Silt separates were found to have high cation-exchange capacities, sometimes greater than those for corresponding clays. The fine sands also exhibited appreciable exchange capacities, the highest again being found usually in the lowest horizon of the profile. Values as high as 20 m.e. per 100 g. were obtained for some of the coarse sands.

Part of the exchange capacity of the separates greater than 2 μ in effective diameter is undoubtedly due to the presence of some clay contaminant, but the actual silt and sand particles also comprise material with considerable exchange capacity.

1374* McConaghy, S. & McAleese, D. M.

Studies on the Basaltic Soils of Northern Ireland. I. Cation-Exchange Properties.

J. Soil Sci. 1957, **8**, 127–34.

Descriptions and analytical data are given relating to nine basaltic profiles representing soils which have been used in detailed studies on cation-exchange properties and mineralogical constitution of basaltic soils in Northern Ireland.

Three main groups of soils are considered: those with impeded or poor drainage, those with free drainage, and those which have good drainage in the agricultural sense but which show slight signs of mottling in lower horizons. In all three groups of basaltic soils the clay contents and the organic-carbon contents fall appreciably with depth, but the cation-exchange-capacity values do not follow the changes in clay and organic-matter contents. The total cation-exchange/capacity in the C or $G_{2\text{-}3}$ horizon may be as high as or higher than in the surface horizon. In freely drained profiles the cation-exchange capacity is generally lower in the B horizon than in the A(S) or in the C horizon, and usually in poorly drained profiles the cation-exchange-capacity value is also lowest in the B, G_1, or the A_2-G horizon (due mainly to the fall in organic matter). Exchangeable magnesium forms a considerable percentage (up to about 40 per cent.) of the total cations in the C (or the G_2) horizons of basaltic soils, and values of the order of 20 m.e. exchangeable magnesium per 100 g. soil are recorded for some such horizons where drainage is impeded.

1369* Perrin, R. M. S.
A Simple Monolith Container.
J. Soil Sci. 1957, **8,** 158–60.
Details are given of the construction of a small, readily portable soil monolith container suitable for reference and teaching collections. Its use and advantages are briefly described.

1398* Rider, N. E.
A Note on the Physics of Soil Temperature.
Weather. 1957, **12,** 241–6.
It is pointed out that in most meteorological problems a knowledge of changes in soil heat rather than in temperature alone is required. The limitations of classical theory in specifying the thermal properties of the soil is illustrated and tests to ascertain the representative nature of soil temperature measurements in one place are described. It is concluded that, because of the difficulties in obtaining values of the thermal diffusivities of soil the best hope for the reliable determination of changes in soil heat lies in the further development of soil flux plates.

1384* Rider, N. E.
Water Losses from Various Land Surfaces.
Quart. J. R. Met. Soc. 1957, **83,** 181–93.
An account is given of observations designed to evaluate the daily water losses from surfaces carrying crops of different size and shape which were transpiring at their potential rates. The losses were obtained by the familiar aerodynamic method, the observations being made over bare soil, brussels sprouts, peas and grass. It is shown that the differences in the water losses from the various surfaces are too large to be accounted for by likely errors in the observations or method. Typical losses for sunny days in the period May to July 1955 were: peas, 2·5 to 7·5 mm; grass, 2 to 3 mm; brussels sprouts, about 4 mm.

1391* Tribe, H. T.
Ecology of Micro-organisms in Soils as Observed during their Development upon Buried Cellulose Film. Pp. 287-98.
Contr. to Microbial Ecology. 7th Sym. *Soc. Gen. Microbiol.* 1957. (Camb. Univ. Press, 32s. 6d.).
A technique is described and illustrated by the use of which it is possible to follow the succession of micro-organisms on a substrate from initial burial in soil to an advanced state of decomposition. The principle is that of direct microscopical observation, together with direct solation of the dominant organisms observed.
A community of actively developing micro-organisms lives on the substrate in a soil environment. A ' normal ' course of development can be studied on a chosen soil type under temperate conditions, with its usual variations due to heterogeneity of soil. After having established this course, deviations from it in other soil types or from particular conditions of soil treatment can be followed. Further, the use of thin sections of other materials, such as wood shavings, for example, will probably stimulate development of other communities from the soil population. By variation thus of substrate, soil and conditions of soil treatment, it should be possible to accumulate information on the inter-relations of quite a number of soil micro-organisms.

OTHER PAPERS

1400* NICHOLSON, H. H. **Some Thoughts about Field Drainage.** *Esso Fmr.* 1957, **9** (3), 18–21.

STATISTICS

*1368 Wishart, J.
An Approximation to the Binomial Distribution.
Incorp. Statist. 1956, 6(3/4), 1–7.
An approximation to the sum of a number of terms of the binomial distribution is given which may be summed up by saying that if we compute

$$\chi^2 = \frac{4}{(q-p)^2}\{p(n+1) + r(q-p)\},\ \nu = \frac{2}{(q-p)^2}(4npq + 1)$$

then the integral of the χ^2_ν distribution from zero to this value is an approximation to the sum of the first r terms of the binomial $(q + p)^n$.

MISCELLANEOUS

1383* Buttress, F. A. assisted by Hughes, G.
Abbreviations.

Quart. Bull. Int. Ass. Agric. Libns. 1957, **2,** 128–35.

The first instalment (AAA-CFA) of abbreviations of professional, scientific and commercial bodies, not confined to agriculture, which will appear in the above Quarterly. The reader may also refer to an earlier work by Buttress (1954) entitled *World List of Abbreviations of Scientific, Technological and Commercial Organizations,* London.

Richens, R. H.

Pre-programming for Mechanical Translation.

Mech. Transl. 1956, 3 (**1**), 20–7.

OTHER PAPERS

ENGLEDOW, F. L. **On Conferences and New Thoughts.** *J. Inst. Corn Merch.* 1956, **5,** 178–81.
MANSFIELD, W. S. **Professor Sir Frank Engledow.** *Golden Sheaf.* 1957, **9** (3), 3–5, 40.
WISHART, J. **Obituary by M. S. Bartlett.** *J. R. Statist. Soc.* **A.** 1956, **119,** 492–3.
WISHART, J. **Obituary by E. S. Pearson.** *Biometrika.* 1957, **44,** 1–8.

BOOKS RECEIVED

THE LIBRARIAN HAS PLEASURE IN BRINGING THE FOLLOWING WORKS TO THE READER'S NOTICE

Agriculture in the British Economy. Proceedings of Conference, Brighton, November, 1956. Pp. 311. (I.C.I. Ltd., London, 1957. 21s.).

BARRON, N. **Pig Farmer's Veterinary Book. 2nd ed.** Pp. XV + 143, with 69 Illus. (Dairy Farmer [Books] Ltd., Ipswich, 1957. 16s.).

BATES, W. N. **Mechanization of Tropical Crops.** Pp. XIII + 410, with 126 Figs and Appendix. (Temple Press Ltd., London, 1957. 45s.).

BLAIR, G. W. SCOTT & REINER, M. **Agricultural Rheology.** Pp. XII + 222, with 62 Figs and 11 Tables. (Routledge and Kegan Paul, London, 1957. 28s.).

CARTER, A. R. **Dutch Lights for Growers and Gardeners.** Pp. 194, with 12 Illus., 8 Figs and 25 Cropping Plans. (Vinton, London, 1956. 12s. 6d.).

CLARKE, H. G. **Practical Shepherding.** Pp. VIII + 61, with 24 Plates. (Farmer and Stock-breeder Publ., London, 1956. 7s. 6d.).

COBLEY, L. S. **An Introduction to the Botany of Tropical Crops.** Pp. XV + 357, with 82 Plates. (Longmans, Green and Co., London, 1956. 37s. 6d.).

CORNWELL, S. V. P. **Management Accounting for Agriculture.** Pp. 84. (Gee, London, 1957. 20s.).

CRADOCK, T. H. **Farm Mechanization Handbook. 3rd ed.** Pp. X + 470, with 298 Illus. (Temple Press Ltd., London, 1957. 25s.).

CULPIN, C. **Farm Machinery. 5th ed.** Pp. 668, with 373 Figs and 13 Tables. (Crosby Lockwood, London, 1957. 35s.).

CUNHA, T. J. **Swine Feeding and Nutrition. Vol. I.** *in a new series on* **Animal Feeding and Nutrition.** Pp. XV + 296, with 46 Figs and 47 Tables. (Interscience Publ. Ltd., London, 1957. 38s.).

DAY, J. WENTWORTH. **Poison on the Land.** Pp. X + 246 (Eyre and Spottiswoode, London, 1957. 25s.).

DOWSON, W. J. **Plant Diseases due to Bacteria. 2nd ed** Pp. XVI + 232, with 30 Figs, 21 Maps and 7 Tables. (Cambridge Univ. Press, London, 1957. 32s. 6d.).

DUDDINGTON, C. L. **The Friendly Fungi : a new approach to the eelworm problem.** Pp. 118, with 24 Illus., 7 Figs and 3 Tables. (Faber & Faber, London, 1957. 21s.).

DUMONT, R. **Types of Rural Economy. Studies in World Agriculture.** Pp. XII + 556, with 27 Maps and Diagrams. (Methuen, London, 1957. 45s.).

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Farmer's Yearbook, Encyclopaedia and Directory of Pedigree Breeders. 3rd issue. Pp. 432, Illus. (Tantivy Press, London, 1957. 12s. 6d.).

FBI Register of British Manufacturers, 1957. 29th ed. Pp. 1124. (Iliffe & Sons, London, 1956. 42s.).

FISHWICK, V. C. **Pigs : their breeding, feeding and management. 6th rev. ed. edited by W. A. Biggar.** Pp. 240, with 32 Plates, 2 Diagrams and 14 Plans. (Crosby Lockwood, London, 1956. 20s.).

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GRABER, L. F. **Laboratory Manual for Students of Agronomy. 9th ed.** Pp. VI + 229, Illus. (Brown, Dubuque, Iowa, $3.25.).

GROVE, A. J. & NEWELL, G. E. **Animal Biology. 5th ed.** Pp. XII + 760, with 621 Figs and 12 Plates. (University Tutorial Press, London, 1957. 25s.).

HAARER, A. E. **Modern Coffee Production.** Pp. XIV + 467, with 36 Figs and 75 Plates. (Leonard Hill, London, 1956. 56s.).

HAMMOND, J. (Ed.). **Progress in the Physiology of Farm Animals. Vol. 3.** Pp. V + 743–1043, with 28 index pages. (Butterworths Sci. Publ., London, 1957. 50s.).

HARLAN, J. R. **Theory and Dynamics of Grassland Agriculture.** Pp. X + 281, with 26 Figs, 7 Plates and 10 Tables. (Van Nostrand [Macmillan & Co., London], 1956. 42s.) .

HEADY, E. O., JOHNSON, G. L. & HARDIN, L. S. **Resource Productivity, Returns to Scale and Farm Size.** Pp. XI + 208, with Tables. (Iowa State College Press, Ames, 1956. $3.50.).

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Index of Agricultural Research, 1957. Agricultural Research Council. Pp. XIV + 189. (Camb. Univ. Press, 1957. 12s. 6d.).

LAMER, M. **World Fertilizer Economy.** Pp. XVI + 715 with many Tables. (Stanford Univ. Press, 1957. $12.50.).

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LING, E. R. **A Textbook of Dairy Chemistry. 3rd ed. Vol. 1. Theoretical.** Pp. X + 227. **Vol. 2. Practical.** Pp. XII + 140. (Chapman & Hall, London, 1956. Vol. 1, 21s. : Vol. 2, 16s.).

MACFADYEN, A. **Animal Ecology. Aims and Methods.** Pp. XX + 264, with 11 Tables, 18 Figs and 6 Plates. (Pitman, London, 1957. 40s.).

McELROY, W. D. & GLASS, B. (Eds). **A Symposium on Inorganic Nitrogen Metabolism.** Pp. XIII + 728, with Figs and Tables. (Johns Hopkins Univ. Press [Oxford Univ. Press, London], 1956. 80s.).

MACHLIS, L. & TORREY, J. G. **Plants in Action. A Laboratory Manual of Plant Physiology.** Pp. VI + 282, with 38 Figs and Appendices. (W. H. Freeman, San Francisco [Bailey Bros. & Swinfen, London], 1956, 31s. 6d.).

McKAY, R. **Crucifer Diseases in Ireland.** Pp. 8 + 78, with 51 Figs. (Sign of the Three Candles, Dublin, 1956. 21s.).

McKAY, R. **Cereal Diseases in Ireland.** Pp. X + 161, with 96 Figs. (Sign of the Three Candles, Dublin, 1957. 21s.).

MACKENZIE, D. **Goat Husbandry.** Pp. 349, with 23 Figs, 31 Plates and 6 Appendices. (Faber & Faber, London, 1957. 36s.).

MAGILL, P. L. *et al.* (Eds). **Air Pollution Handbook.** Pp. XI + 670, with many Figs and Tables. (McGraw-Hill, New York & London, 1956. 112s. 6d.).

MAXIMOV, A. A. & BLOOM, W. **Textbook of Histology. 7th ed.** Pp. VIII + 628, with 632 Figs. (Saunders, Philadelphia & London, 1957. 77s.).

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